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AAA Rupture Often Occurs Outside the Maximal Diameter Region and is Preceded by Rapid Local Growth and an Increased Biomechanical Rupture Risk Index

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Introduction: Rupture risk prediction of abdominal aortic aneurysms (AAA) relies on maximal diameter (Dmax) measurements. If Dmax exceeds 55 mm aortic surgery is considered beneficial. However, even small aneurysms rupture while some large aneurysms never rupture. Our objective was to study the size and location of ruptures in AA patients in our center and to relate the location and growth of the local rupture site to the Dmax. Furthermore, we studied whether the biomechanical rupture risk estimated using finite element analysis (FEA) could predict rupture.

Methods: All patients diagnosed with AAA rupture (treated or not treated) in our catchment area during the years 2009–2013 were included. 50 patients had undergone high quality computed tomography angiography examination. Dmax, orthogonally to the centerline, local diameter at the rupture site and its distance from the Dmax region was recorded. 14 patients had a previous CTA conducted within 2 years prior to AAA rupture. FEA was performed and Peak wall stress (PWS) and Peak wall rupture index (PWRI = maximal wall stress/wall strength ratio) were calculated using A4 Clinics software (VASCOPS, Austria).

Results: The median diameter at rupture was 77 mm. Two rAAAs (4%) had a Dmax $<$55 mm and five (10%) had a Dmax $<$60 mm. 50% of the 30 identified rupture sites were located outside the Dmax region. In the 14 patients with a pre-rupture CTA, PWRI was significantly higher than in the control group (0.41 vs. 0.34, $p = 0.005$) but no significant differences in PWS (212 vs. 197 kPa, $p = 0.20$) or maximal diameter (61 vs. 58 mm, $p = 0.23$) were detected. Diameter growth rate between the pre-rupture and rupture CTs was in 67% of the cases higher in the rupture region than in the Dmax region.

Conclusion: In this cohort of all consecutive rAAA patients (treated and not treated), a significant number of ruptured aneurysms had small diameters at rupture. Ruptures often occurred outside the maximal diameter area, sometimes in segments with a relatively small local diameter. In the small cohort of rupture patients with a pre-rupture CTA, FEA could predict AAA rupture. In addition, rupture sites were preceded by rapid local growth. Our results support the notion of considering the entire geometry of an aneurysm, rather than sole reliance on maximum diameter measurements.

Comparison of Renal Outcomes in Matched Cohorts Treated by Zenith® Fenestrated and Zenith® AAA Stent Grafts in US Prospective Pivotal Trials

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Introduction: Fenestrated endovascular repair (FEVAR) has been increasingly utilized to treat complex abdominal aortic aneurysms (AAAs). The added risk of renal function deterioration as compared to patients undergoing infra-renal endovascular aortic repair (EVAR) has not yet been determined.

Methods: Patients with preserved renal function (eGFR $\geq$ 45 ml/min) enrolled in two prospective, non-randomized pivotal studies evaluating the Zenith® fenestrated and Zenith® AAA stent grafts (Cook Medical Inc., Bloomington IN) were matched (1:2) by propensity scores for age, gender, hypertension, diabetes, and pre-operative eGFR. There were 67 patients treated by FEVAR and 134 matched controls treated by EVAR. Mean follow up was 30 $\pm$ 20 months. Renal outcomes included acute kidney injuries defined by RIFLE criteria (Risk, Injury, Failure, Loss, End-stage) and changes in sCr, eGFR, and CKD staging up to 5 years. Renal duplex ultrasound follow up was obtained only in the FEVAR group.

Results: Acute kidney injury at one month were similar between groups with $>$50% decline in eGFR observed in 6% of FEVAR and 11% of EVAR patients ($P = 0.68$). There were no significant differences in $>$25% decline in eGFR at 2-years (20% vs. 20%; $P = 0.99$) and 5 years (27% vs. 50%, $P = 0.50$) between patients treated by FEVAR or EVAR, respectively. Progression to stage IV-V CKD was similar at 2-years (2% vs. 3%; $P = 0.99$) and 5 years (7% vs. 8%, $P = 0.94$) in the FEVAR and EVAR groups, with similar sCr and eGFR values up to 5 years. During follow up, there were more renal artery stenosis/occlusions (15/67 vs. 3/134, $P < 0.001$) and more renal related re-interventions (12/67 vs. 4/134, $p < 0.001$) in patients treated by FEVAR compared to EVAR, respectively. However, rate of progression to renal failure requiring dialysis was low and identical in both groups (1.4% vs. 1.4%, $P = 0.99$).

Conclusion: Endovascular aortic repair with fenestrated and infra-renal AAA stent grafts was associated with similar rates of renal function deterioration in patients who initially had preserved renal function. Renal-related re-interventions were higher following FEVAR, although net changes in renal function were similar in both groups. Surveillance of renal artery alignment stents is recommended to detect stenosis or occlusion after FEVAR. In patients with preserved renal function, the decision on type of repair should be based upon anatomical factors such as length of infra-renal aortic sealing zone and aneurysm involvement of the visceral arteries, rather than impact on renal function status.

Can EVAS Win the Race Against EVAR? Our Experience with 50 Nellix Implantations.

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Introduction: The Nellix Endovascular Aneurysm Sealing (EVAS) has been proposed as an alternative to conventional endovascular aneurysm repair in attempt to deal with the limitations of this method, specifically, endoleaks and migration. The aim of the study was to present our experience in the treatment of patients with abdominal aortic aneurysms (AAA) with challenging neck anatomy.

Methods: From January 2014 to April 2015, 50 patients (43 male, 7 female), aged 56–87, underwent implantation of Nellix stent graft for AAA. In one case an emergency procedure was performed in a patient with secondary aneurysm rupture due to bifurcated stent graft migration. The procedures were performed under spinal (41) or general anesthesia (9).

Results: All procedures were completed without complications. In five cases the procedure was performed beyond instruction for use. Four renal

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chimney Advanta V12 stent grafts were used (one unilateral and three bilateral) from axillary access. In one case aorto-uniiliac Nellix was implanted with cross-over by-pass. The decision was made during the procedure when there was no possibility to introduce one of the stent grafts due to tortuous and calcified iliac artery. The mean length of hospital stay was 6 days, four patients were sent to intensive care unit for one day after the procedure. No endoleaks were noticed during the procedure and during follow up. All prostheses remain patent. One patient was readmitted on 17th post-operative day due to secondary aneurysm rupture. Open conversion was performed, the Nellix stent graft was explanted and replaced with a bifurcated graft. Further follow up was uneventful.

Conclusion: EVAS is an innovate concept in the treatment of AAA designed to target the causes of secondary interventions such as endoleaks and migration. It offers an alternative for patients unsuitable for fenestrated devices or open surgery. Results of the chimney technique, though beyond the instruction for use for the procedure, are very promising and in particular cases it can be an alternative to custom made fenestrated stent grafts reducing costs and shortening the time of waiting for interventions.

Aorto-Enteric Fistula following Endovascular Aortic Repair: Results from the Multicenter study on Aorto-Enteric FIstulization after STent grafting Of the abdominal aorta (MAEFISTO)

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Introduction: As the number of patients treated with endovascular abdominal aortic repair (EVAR) is considerably growing in recent years, related complications are observed with increasing frequency. Among these, aortoenteric fistula (AEF) is known to be a dramatic and highly lethal event, but evidence in the literature is scant and mainly based on single center case reports. Aim of this study is to investigate the incidence, clinical features, therapeutic options, and outcomes of AEF developing after EVAR.

Methods: A retrospective multicenter study was conducted among eight Italian universities and hospital centers with an abdominal aortic endovascular program, to collect data on AEF developed after EVAR performed for non-infectious disease.

Results: Among 3,932 patients who underwent EVAR between 1997 and 2013, 32 (0.8%; 27 males, mean age 72 $\pm$ 8 years) developed an AEF. Median time between EVAR and AEF formation was 18.5 months (interquartile range, IQR: 10.5—63.5 months). Both anastomotic pseudoaneurysm as the indication to EVAR, and urgent/emergent EVAR resulted significantly associated with AEF development (34% vs. 5%, $P < 0.0001$; and 22% vs. 8%, $P = 0.01$; respectively). Among 5 patients treated conservatively, 2 (40%) died at 7 and 15 months respectively, while the other 3 are alive at a median follow up of 12 months (IQR: 7—15). The remaining 27 patients underwent AEF surgical treatment, with a perioperative mortality of 37% ($n = 10$). No additional aortic related death was recorded in operated patients at a median follow up of 28 months (IQR: 14—42).

Conclusion: Late AEF may occur in less than 1% of patients submitted to EVAR, with an increased risk in case of emergent EVAR or performed for pseudoaneurysm following previous aortic surgery. Both conservative and surgical treatment of post-EVAR AEF is associated with high mortality. However, beyond the peri-operative period, surgical correction of AEF appears to be durable at mid-term follow up.

Internal Iliac Aneurysms have a Low Risk of Rupture under 4 cm: A Multicentre Study

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Introduction: Internal iliac artery aneurysms are rare and their risk of rupture is unknown. The definition of common iliac aneurysm is a maximum diameter of greater than 18—20 mm, but there is no clear diameter definition for internal iliac aneurysms. The threshold for elective repair in iliac aneurysms is commonly 30 mm. However, no strong scientific data exists on the risk of rupture. The aim of the current study was to evaluate the size of internal iliac aneurysm at the time of rupture.

Methods: This was a retrospective multicentre study including patients with ruptured internal iliac artery aneurysm (RIIAA) from Australia, Finland, Germany, Hungary, New Zealand, Norway and Sweden. The data on aneurysm size at the time of rupture, information on concomitant aneurysms in aorta, ipsilateral common iliac artery as well as contralateral iliac arteries, treatment of the RIIAA as well as outcome were collected from CT-images and patients' case records.

Results: In total 59 RIIAA patients were treated during 2004—2014. Median diameter at the time of rupture was 67.5 mm (IQR 52—85 mm, range 25 —116 mm). In one patient (1.8%) the maximum diameter was less than 3 cm, in 3 patients (5.5%) less than 4 cm. Mean age at the time of rupture was 77 years. 86% of patients were men. 57% had bilateral IIAA, 64% also had an aneurysmal common iliac artery and 44% also had AAA. 38% had involvement of internal and common iliac arteries and the aorta. 29% had an isolated internal iliac aneurysm. Repair by either open procedure ($n = 42$, 71%), endovascular procedure ($n = 12$, 20%) or hybrid procedure ($n = 5$, 8.5%) was performed on all patients. 30 day mortality was 19%; 8.3% after endovascular treatment, 21% after open surgery and 20% after a hybrid procedure.

Conclusion: Internal iliac artery aneurysm ruptures are rare. As with RAAA most of the patients are male. Compared to operative RAAA mortality, RIIAA mortality seems to be somewhat lower with less than 20 % mortality at 30 days. The median size of the aneurysm at the time of rupture was 67 mm, compared to 76 mm in abdominal aortic aneurysms. Only one patient had a rupture at a diameter of less than 3 cm, which suggests that the threshold for elective treatment might be quite safely increased to 4 cm.

Comparative Effectiveness of Endovascular versus Open Repair for Juxta- and Suprarenal Abdominal Aortic Aneurysms

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Introduction: With the advancement of endovascular techniques (EVAR) for abdominal aortic aneurysm repair (AAA), the number of patients treated for juxta- and suprarenal aneurysms with EVAR is increasing. During the adoption of new treatment strategies, it is important to track performances and compare results to conventional treatment. The purpose of this study was, therefore, to examine perioperative outcomes in patients undergoing endovascular juxta- and suprarenal AAA repair and compare those results to conventional open repair.

Methods: We identified all patients undergoing non-emergent EVAR or open repair for juxta- and suprarenal AAA between January 2003 and December 2014 in the Targeted Vascular data set from the American College of Surgeons National Surgical Quality Improvement Program. Comparative analyses included patient and intraoperative characteristics, in addition to 30-day postoperative outcomes. Independent risk factors for morbidity and mortality were established using multivariable logistic regression analysis.

Results: A total of 907 patients were included, with 411 (45%) undergoing EVAR, and 496 (55%) undergoing open repair. Perioperative mortality following EVAR was 2.2% vs. 4.6% after open repair ($P = .047$). Postoperative deterioration of renal function was less common among patients undergoing EVAR (2.2% vs. 8.7%, $P < .001$), as well as the need for dialysis (1.2% and 5.2%, $P = .001$). Other differences in perioperative morbidity after EVAR and open repair, respectively, included the occurrence of ischemic colitis (1.0% vs. 5.0%, $P < .001$), myocardial infarction (0.7% vs. 3.8%, $P = .002$), wound dehiscence (0.2% vs. 2.6%, $P = .005$), pneumonia (1.2% vs. 7.9%, $P < .001$), prolonged ventilator dependence (1.9% vs. 13.5%, $P < .001$)